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CEMENT TESTING

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THE FAIRBANKS CO.
NEW YORK.

CATALOGUE No. 379.

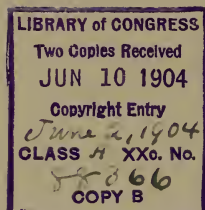
CATALOGUE No. 379

CEMENT TESTING

THE FAIRBANKS CO.
"NEW YORK

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1904



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PREFACE.

It has been our aim in preparing the following pages to give a few practical suggestions as to the methods of operating the various appliances sold by us for cement testing.

We have written for those who have not had the advantage of a technical education rather than for the engineer.

Every engineer possesses strong views on this subject; views which differ so widely as to thoroughly confuse the layman. It is to prevent this confusion that we have prepared this treatise. The opinions expressed are those arrived at after impartial consideration of written and orally expressed views of a number of cement experts.

The unprecedented demand for the implements described hereafter, and for information as to their use and operation, is our excuse for this publication.

Any suggestions or criticism which will tend to improve the methods of testing cement or the construction of the appliances will be gratefully received, and, so far as possible, acted upon.

Our thanks are due to *Cement* for much valuable information.

THE FAIRBANKS CO.

NEW YORK, June 1, 1904.

*The following has been inserted by request ; many of
us use the terms with some doubt as to
their meaning :*

PORTLAND CEMENT (named from its resemblance in color to Portland Stone) is an artificial cement, manufactured from selected materials, commonly limestone and clay, with other materials, which vary with each brand.

ROSENDALE, NATURAL OR ROMAN CEMENT is made from a limestone more or less impure, or a stone composed of carbonate of lime with sand and clay ; calcining fits it for use. Named Rosendale from the town in New York where it is largely worked, or Roman from a fancied resemblance to Roman mortar.

HYDRAULIC CEMENT.—Any cement which sets or hardens under water.

NEAT CEMENT is cement mixed with water only.

CONCRETE.—A mixture of cement, sand, stone or pebbles and water.

BETON—A kind of concrete formed of lime, sand and gravel ; is much used as a hydraulic cement in submarine work.

THE DEVELOPMENT OF THE CEMENT TESTING MACHINE.

EVERY review of the manufacture of Portland cement begins with Smeaton in connection with the building of the Eddystone Lighthouse, in 1756. The history of cement testing likewise begins with that able experimenter. Smeaton's methods, which enabled him to obtain the relative hydraulic qualities of various mixtures, consisted in simply immersing samples in water for a certain period of time, and then subjecting them to a comparative examination.

Vicat devised an apparatus to obtain the relative degree of hardness of cements, resembling somewhat the Vicat needles now used to determine the setting time. Vicat allowed a weighted needle to fall upon the sample of cement, and by measuring the length of penetration obtained the degree of hardness. A common practice among builders, in 1825, was to prepare the mortar as they intended to use it in the work, and then stick bricks together with it, one at a time, projecting horizontally from a wall. The mortar used in the line containing the greatest number of bricks was considered the strongest.

The next step in the advancement of cement testing occurred in 1830, when General Palsey, inspector of the Royal Engineers' School, at Chatham, England, began his investigations of hydraulic cements, which led him to devise means of ascertaining the strength of the cements he produced. His method consisted of sticking two bricks together, and then, by means of a clamp

fastened to one, he suspended them from a tripod. A clamp was also fastened to the lower brick, which carried the weights as they were gradually applied. The weight necessary to pull the bricks apart was considered as representing the strength of the mortar.

Another test came into use during the construction of the Houses of Parliament, in 1843, when the contractors conducted a series of comparative tests between Roman and Portland cements, which consisted in ascertaining the breaking weights of brick beams and cantilevers cemented with Roman and Portland mortars.

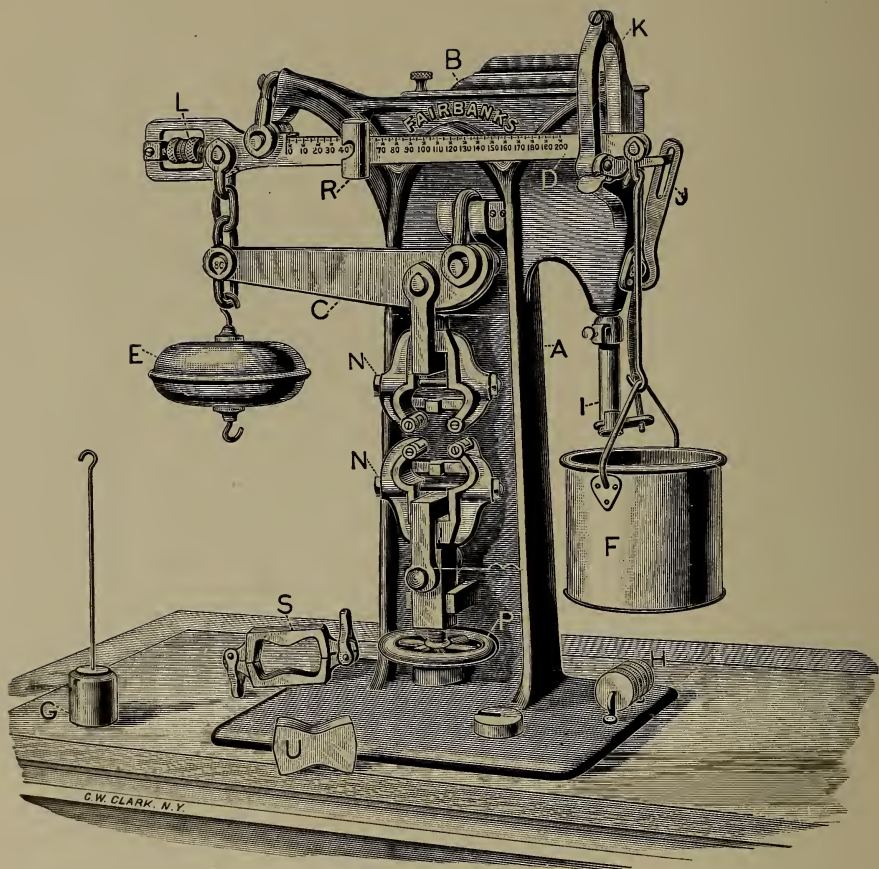
The result of this test was also the means of greatly advancing the reputation of Portland cement. The competition between the manufacturers of Roman and Portland cements to demonstrate the superiority of their respective products stimulated the search for improvements in testing methods and machines.

Experiments were made in 1848 with a view of demonstrating the advisability of making tests of the crushing strength of concrete. The attention of engineers was, however, directed toward perfecting the test for tensile strength, and in 1851 cement briquettes came into use, and experiments were made at public exhibitions showing their great tensile strength. Cement testing in a thorough and systematic manner did not become a reality until 1859, when John Grant, M. I. C. E., devised a testing machine and formulated rules governing its operation, and published his views concerning the practice of cement testing in general.

The development of cement testing was now more firmly directed toward utilizing the test for tensile strength, and while progress was necessarily slow, yet a number of machines appeared on the market. Henry Faija and Michaelis invented machines that bear their names. With the increase in the consump-

tion of cement and its adoption for use in important works, the value of scientific testing became an important and necessary requirement. It developed that the wide difference in results obtained from the same sample could be avoided by eliminating, as far as possible, the direct control of the operator over the machine during the application of the strain. The strain must be applied in a uniform manner, subjecting each briquette to like conditions; the operation must necessarily be automatic.

There was also room for improvement in the construction of the clips and other parts. Step by step, improvement upon improvement, and, finally, from the crudest methods, through years of effort and gradual advancement, the Fairbanks Testing Machine came into the field, and its success became at once assured. It embodied the principles so long sought for. It became at once the *standard*, and, by reason of the manufacturers' efforts in constantly improving their machine, wherever experience in manufacture and investigation concerning its operation dictated, the Fairbanks Testing Machine has always maintained its position as the standard cement testing machine; and no better evidence of this fact, outside of its almost exclusive use, can be offered than the *Progress Report of the Special Committee on the Proper Manipulation of Tests of Cement of the American Society of Civil Engineers*, in which it states that in answer to question 59—"What style of testing machine do you prefer?"—which was sent to the members of the Society, sixteen answers indicated a preference for the Fairbanks machine, against three for another make and one for still another style; while two, including one German manufacturer, indicated a preference for a third type of machine. It is therefore apparent, from these expressed opinions of those who are qualified to judge, that the Fairbanks machine is unquestionably the *standard*.—Reprinted from *Cement*, May, 1902.



TESTING MACHINE. FIG. 1.

CEMENT TESTING.

THE testing of cement is an operation which is open to considerable variation and discussion. "Personal equation" enters into it so largely that it is virtually impossible to obtain tests, made by two or more persons, even under practically identical conditions, which will show the same results. For this reason one should hesitate before rejecting material which is apparently not up to the standard, unless one has satisfied himself that he has complied with all necessary precautions and made all proper allowances.

Cement testing is, after all, somewhat arbitrary and chiefly valuable as a means of comparison. First in importance we may place the

Testing Machine.

This, though the final implement in making tests, may properly be treated first.

To quote a well known authority, "the type, . . . in which the weight is applied by a stream of shot, which runs from a reservoir into a pail suspended at the end of a steelyard arm, when the briquette breaks the arm falls, automatically cutting off the flow of shot, . . . is that officially recognized in Germany

and France, and is decidedly preferable on account of its greater simplicity, smaller bulk and regular application of the weight."

The Fairbanks machine is of this type, and will be best understood from the following:

Directions for Its Use.

Hang the cup F on the end of the beam D, as shown in the illustration (Fig. 1).

See that the poise R is at the zero mark, and balance the beam by turning the ball L.

Fill the hopper B with fine shot (of which a bag is provided with each machine).

Place the briquette in the clamps N, N.

It is of the utmost importance that the clamps be carefully adjusted to the briquette, using great care to place the specimen in such a manner that the four rollers which grip the briquette will be parallel; if this is not done a side strain will be exerted which will cause the briquette to break between the jaws of the clamps and not at the smallest section.

Tighten the hand wheel P sufficiently to cause the graduated beam D to rise to the stop K.

Only enough pressure should be exerted to hold the beam firmly against the stop; not enough to transmit any strain to the specimen.

Open the automatic valve J, so as to allow the shot to run into the cup F.

At the point where the spout joins the reservoirs will be noticed a small valve, by which the flow of shot may be regulated.

DIRECTIONS FOR USING

Better results will be obtained by allowing the shot to run very slowly into the cup.

When the briquette breaks, the beam D will drop and automatically close the valve J.

Certain cements stretch or give to such an extent as to allow the beam to strike the valve before the specimen breaks.

If this should occur, carefully raise the end of the beam with one hand until it again touches the stop K; with the other hand gently tighten the hand wheel sufficiently to hold the beam in place, and again allow the shot to run.

Under no circumstances should the wheel be tightened before the beam has been lifted against the stop, as such action invariably causes the specimen to break, rendering an accurate test impossible.

After the specimen has broken, remove the cup, with its contents, hanging the counterpoise G in its place.

Hang the cup F on the hook under the large ball E, and proceed to weigh the shot in the regular manner, using the poise R on the graduated beam D and the weights H on the counterpoise weight G.

The result will show the number of pounds required to break the specimen.

It has several times come to our notice that many users of these machines have been in the habit of applying an arbitrary strain by means of the hand wheel, adding this strain to the actual result obtained in the proper manner. As one young man expressed it: "We apply pressure with the hand wheel equal to about four hundred pounds, as the other way is so slow."

This is so obviously unfair as to need no comment.

Do not fall into the common error of taking the average of a certain number of breaks and calling that average the maximum breaking strain. This is manifestly unfair to the cement.

It is self evident that if all the briquettes could be molded under exactly similar conditions, as regards filling and pressure, and uniformly adjusted in the clamps, the results would be identical.

These are the points which cause the variations which are so common, and until a uniform system can be devised, or the "personal equation" eliminated, it is only just to accept the specimens which show the highest efficiency, rejecting all which fail to break at the smallest section.

The Fairbanks Cement Tester is constructed upon the same principle as a scale, the clamps being hung from levers by hardened points to reduce the side strain.

These levers are sealed to a regular multiplication, which transmits to the shot cup on the end of the beam its proper proportion of the strain, the levers and beam being hung by hardened steel loops and pivots after the most approved Fairbanks method of scale construction.

There are no springs or hydraulic apparatus, the action being automatic and entirely free from jars which would tend to break the specimen before its greatest efficiency had been reached. The tensile strain is generally accepted as the standard, it being less difficult to obtain fair comparisons than by other methods.

IMPROVED CEMENT TESTING MACHINE.

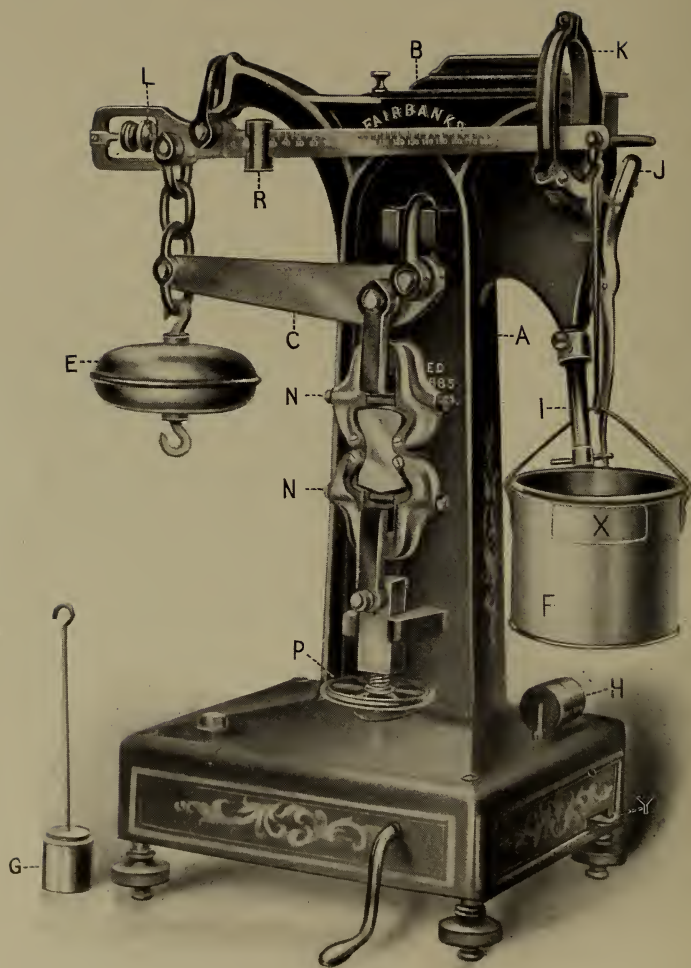
The illustration on the following page shows the latest device for testing cement. By its use a steady tension is applied to the briquette until it is broken.

Owing to the greatly increased tensile strength of cement, we think this is the only machine on the market which will make accurate tests. It is our regular No. 3184 Cement Testing Machine, equipped with a sub-base containing worm and worm gear connected to an axis, which is threaded and passes up through the base and hand wheel P into a block, and the latter connected to the lower clamp. The gear is actuated by the worm, the end of which is fitted to receive a key crank, passing through the front of the sub-base. A hook lever Y on right hand end of sub-base serves to disengage the worm from the gear, then the hand wheel P may be used for rapid adjustment in returning clamps to position to receive the next briquette after one has been broken.

**INCREASED
TENSILE
STRENGTH.**

The beam is provided with an indicator, which affords a guide for keeping it in equilibrium. A supplementary brass weight X is provided to attach to the shot bucket, which secures an initial pull of ten pounds on briquette when beam is in level position. The supplementary weight is never disturbed, except when it is desired to test or balance the machine, when it must be taken off.

In operation, the briquette is placed in the clamps and adjustment made by hand wheel P until the indicators are in line. By



IMPROVED
CEMENT TESTING MACHINE.

means of hook lever Y the worm is now engaged with gear. The shot valve is then opened, allowing the shot to run into the bucket. The crank is turned with sufficient speed to hold the beam in equilibrium until the briquette is broken. The weighing of the shot to determine breaking strain on the briquette is the same as described on page 13 for the machine without sub-base.

We are prepared to furnish either our No. 3184 or our No. 3176 machine with this attachment, at an additional price of \$50.00 net; or we are prepared to put this attachment on either of the above machines at the same additional cost.

Testing for Fineness.

The first operation in cement testing is testing for fineness.

**TESTING
CEMENT FOR
FINENESS**

The percentage scale No. 485 (Fig. 2) has on the beam its full capacity of 16 ounces by one-half ounce, a second row of figures graduating the beam from 0 to 100 per cent.

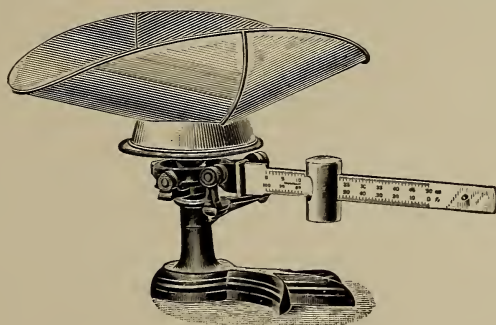


Fig. 2.

Weigh 16 ounces of cement and pass it through the coarsest sieve of set No. 100 (see Appendix); then put the cement back

into the scoop and move the poise on the beam until the scale balances.

The lower row of figures will indicate the percentage of residue.

Repeat this operation with each of the sieves, in order of fineness.

Specifications vary so much that we give the following simply as an illustration: 100 per cent. should pass through sieve No. 101, 90 per cent. through sieve No. 102 and 80 per cent. through sieve No. 103.

The A. S. C. E. recommends that 100 per cent. be able to pass through sieve No. 103, which in view of the improved machinery is not unreasonable.

The fineness is very important, as the tensile strength of cement is in direct proportion thereto.

By making several draughts, the No. 485 scale may be used in place of the No. 712 scale (Fig. 3).

Mixing.

The comparative value of tests made with cement neat or that mixed with sand is a much mooted question. The consensus of opinion, however, is that the test with sand, prescribed by the *MIXING* German Government, viz., three parts of sand to one of cement, is preferable, as it more nearly approaches the condition under which cement is used.

The so called sand is ground quartz, which is sharp and clean, and practically uniform in size.

This should be of such size that 100 per cent. will pass through sieve No. 204 of set No. 200 (see Appendix) and be caught on the No. 205 sieve ; in other words, mix with the cement only the sand which passes through the coarse, but will not pass through the fine sieve, discarding the balance.

This point is very important, for many irregular breaks are due to the presence of large pieces of sand.

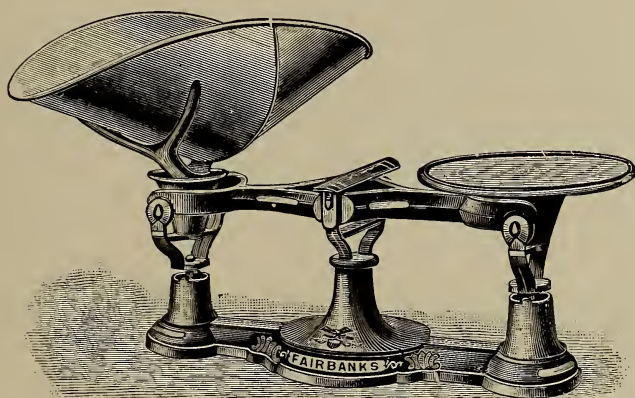


Fig. 3.

The even balance scale No. 712 (Fig. 3) is to be used for weighing out larger quantities of both cement and sand after they have been sifted.

The sand and cement should be thoroughly mixed together dry, and the entire amount of water added *at one time*.

The proportion of water is as follows: For neat Portland, **PROPORTION OF WATER** 20 per cent. ; for neat natural cement, 25 per cent. ; for 3 parts sand to 1 of cement, 10 per cent.

The graduated measuring glass (Fig. 4) is intended for measuring the water.

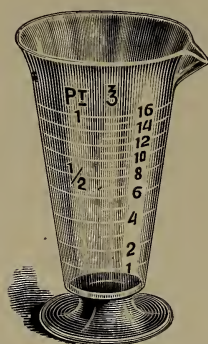


Fig. 4.

The mixture should be thoroughly worked with a trowel for full five minutes.

This is the German standard, and is very necessary, especially for sand mixtures, as the success of the test depends largely upon the thorough mixing of the sand, cement and water.



GANG MOLDS.



NO. 3194.—SINGLE MOLD.



NO. 3196.—SINGLE MOLD.

Fig. 5.

The mixture is now ready for the

Molds.

These are of two patterns, each forming the standard briquette, with a small section of 1 square inch, No. 3194 being furnished unless otherwise ordered. The molds are laid on the glass plate (Fig. 6), and filled with cement by the small trowel.

The mixture should be firmly pressed in place, so as to fill every part of the mold, and struck off even. **BRIQUETTE
MOLDS**



Fig. 6.

The amount of pressure exerted is a point which causes considerable of the variation in the results obtained, and is, therefore, quite important.

Many engineers recommend filling the mold with a trifle more mortar than required, then placing a piece of wood over the mold and striking a few blows with a light mallet.

The surplus should be cut off with a knife, and the briquette smoothed down with the trowel.

The glass plate should always be used, as an absorbent material will cause the briquettes to dry unevenly.

As soon as the briquettes have set sufficiently, the molds should be carefully removed and the briquettes covered with a damp cloth for twenty-four hours.

At the end of this time they should be immersed in water in the galvanized iron pan (Fig. 7) and left there until ready to test.

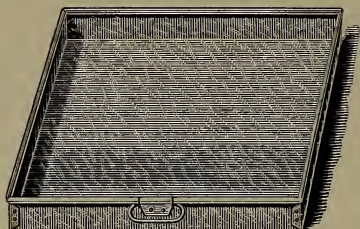


Fig. 7.

How to operate the machine has already been shown.

At least five molds are required, one being furnished with each machine.

The Vicat and Gilmore Needles.

Both of these are used to obtain the rate of setting of cements.

The Vicat is used as follows:

VICAT APPARATUS

The cylindrical rubber mold is filled with a mixture of neat cement and water, enough water being used to give a plastic consistency (the proportions given under the head of "Mixing" should be followed).

The mold is 10 centimeters in diameter and 4 in height, and is to be placed on the glass plate which forms part of the apparatus (Fig. 8) before filling.

It will be noticed that the machine is supplied with a plunger 1 centimeter in diameter, and a needle with a diameter of 1 millimeter, each being provided with a brass disk which fits on the top

of the piston, the lighter being used with the plunger. In some forms of the machine the disk which is used with the plunger remains permanently upon the piston, a light disk being placed upon this when the needle is to be used.

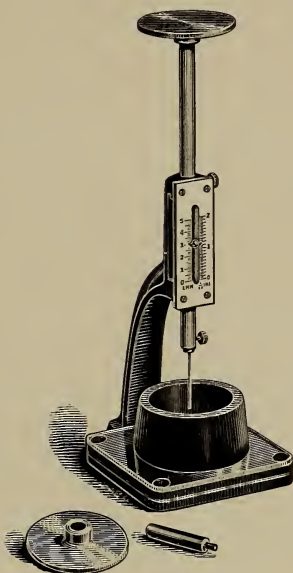


Fig. 8.

The face of the apparatus bears a scale, graduated in millimeters and fractions of an inch, a double pointer being carried by the piston, indicating on the scale the depth of penetration.

After the mold is filled with the mortar it is placed in the apparatus, as shown in the cut (Fig. 8). The plunger is then allowed to sink into the cement by the weight of the disk.

If the plunger penetrates to a point 6 millimeters from the bottom the mortar is of the proper consistency.

The needle is then substituted for the plunger. The time when the needle first refuses to sink entirely through the mortar is observed and noted as the beginning of setting ; when the needle first rests upon the briquette without penetrating, the moment of final setting.

**GILMORE
NEEDLES**

The Test Wires or Gilmore Needles (Fig. 9) consist (a) of a steel needle one-twelfth of an inch in diameter, loaded with a weight of one-quarter pound, and (b) of a steel needle one-twenty-fourth of an inch in diameter and a weight of 1 pound.

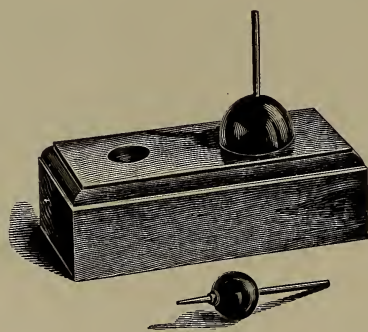


Fig. 9.

In use these are held lightly in a vertical position between the fingers, the point resting upon the specimen.

The moment when the coarse needle fails to sink into the cement is called the time of initial setting ; when the fine needle will no longer penetrate, the moment of final setting.

These needles are also used in connection with the Pat Test.

The Pat Test.

This test, which is for checking or cracking, is considered by the majority of cement users as of great importance, and is as follows:

Mold on small plates of glass two cakes or pats of neat cement 2 or 3 inches in diameter and about one-half inch thick in the centre, with thin edges.

These should have the consistency of stiff plastic mortar.

Test these cakes with the Gilmore needles, as above, noting carefully and recording the time of setting in minutes, both initial and final; after the final setting cover with wet cloths for twenty-four hours; then expose one to the air and place the other in water.

Examine carefully from day to day for checks or cracks.

The expansion cracks are radial, and occur at the edge of **FOR EXPANSION**

These cracks are due to free or imperfectly combined lime, which slakes and causes the cement to expand with a force which is irresistible.

This is the dangerous condition, to detect which the test is made.

When too much water is used, irregular shrinkage takes place, causing cracks which must not be confounded with those caused by expansion. It is to prevent this shrinkage that the pats are covered with the wet cloths until perfectly hard.

The pat which is left in the air is for the color test.

Good cement, either Portland or natural, should have a uniform color while drying—yellowish spots indicating a poor quality. **FOR COLOR**

The color in air indicates the quality much more surely than when in water.

Trowels.

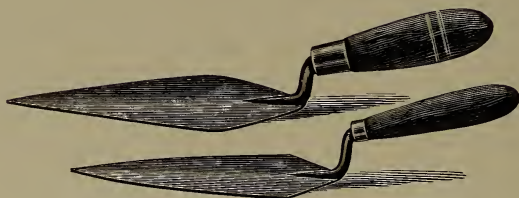


Fig. 10.

TROWELS The large trowel is for mixing the mortar ; the small trowel for placing it in the molds.

Many persons prefer a spatula (a broad flat knife, straight across the end and very stiff) for the last named purpose.

Sampler.

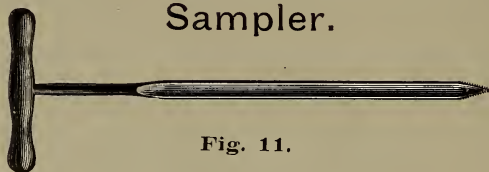


Fig. 11.

SAMPLER For obtaining samples of cement from the center of the barrel ; the point being an auger, enabling one to bore through the staves.

Sample Cans.

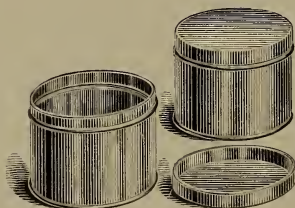


Fig. 12.

SAMPLE CANS These have tightly fitting covers and are to contain samples of various cements tested.

APPENDIX.

Prices of the articles described and illustrated in the foregoing:

Testing Machines	{ 3182.... 600 lbs. Size 12 × 24 in.	\$85.00
(Fig. 1).	{ 3184.... 1,000 " " 12 × 24 "	110.00

Testing Machine, 3184, Improved Base, 1,000 lbs. capacity.....	160.00
--	--------

Prices of machines of greater capacity furnished upon application.

Improved base may be fitted to old style machines at a net cost of \$50.

Molds (Fig. 5) ..	{ 3194.....	4.00
	{ 3196.....	4.00
Gang Molds....	{ Two gang.....	8.00
	{ Three gang.....	12.00
	{ Four gang.....	16.00

(Fig. 2) No. 485 Scale.....	6.00
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(Fig. 3) No. 712 Scale, with brass weights.....	6.00
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(Fig. 4) Measuring Glass, 16 oz.....	1.00
--------------------------------------	------

(Fig. 6) Glass Plate (ground), 24 in. × 24 in.....	8.00
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(Fig. 7) Galvanized Iron Pan, 24 in. × 24 in. × 3 in....	2.00
--	------

(Fig. 8) Vicat Apparatus.....	30.00
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Special Vicat Apparatus.....	35.00
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(Fig. 9) Gilmore Needles or Test Wires.....	5.00
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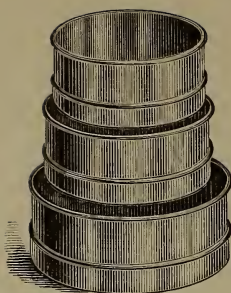
(Fig. 10) Trowels	{ Large.....	1.00
	{ Small.....	.75

(Fig. 11) Sampler.....	7.50
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(Fig. 12) Sample cans, per dozen.....	1.00
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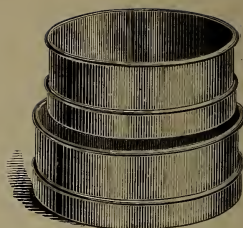
Keg A. S. C. E. Sand, about 125 lbs.....	4.75
--	------

Barrel A. S. C. E. Sand, about 350 lbs.....	10.50
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SIEVES.

Order Sieves by number, stating (if Sets are ordered) whether brass or tin frames are desired.



SET No. 100—CEMENT TEST SIEVES.

Each Set comprising the following :

With Tin Frames. No.	With Brass Frames. No.	No. of Meshes to the Inch.	No. of Meshes to Sq. Inch.	Stubbs' Wire Gauge.	Diameter in Inches.	Prices. Each. Per Set.	
101		50	2,500	35	6	\$2.00	\$7.25
102		74	5,476	37	6½	2.50	
103		100	10,000	40	7	2.75	
....	111	50	2,500	35	6	2.25	8.00
....	112	74	5,476	37	6½	2.75	
....	113	100	10,000	40	7	3.00	

SET No. 200—SAND TEST SIEVES.

Each Set comprising the following :

With Tin Frames. No.	With Brass Frames. No.	No. of Meshes to the Inch.	No. of Meshes to Sq. Inch.	Stubbs' Wire Gauge.	Diameter in Inches.	Prices. Each. Per Set.	
204		20	400	28	7½	\$2.25	\$5.00
205		30	900	31	8	2.75	
....	214	20	400	28	7½	2.50	5.50
....	215	30	900	31	8	3.00	

SET No. 300—CEMENT TEST SIEVES.

WITH LID AND BOTTOM.

Each Set comprising the following :

With Tin Frames. No.	With Brass Frames. No.	No. of Meshes to the Inch.	No. of Meshes to Sq. Inch.	Stubbs' Wire Gauge.	Diameter in Inches.	Price Per Set.
....	301	50	2,500	35	6	\$11.00
....	302	74	5,476	37	6	
....	303	100	10,000	40	6	

SET No. 400—SAND TEST SIEVES.

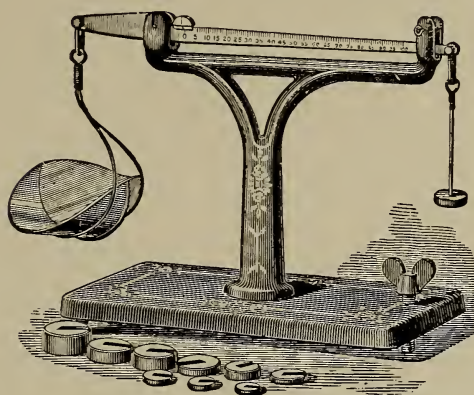
WITH LID AND BOTTOM.

Each Set comprising the following :

With Tin Frames. No.	With Brass Frames. No.	No. of Meshes to the Inch.	No. of Meshes to Sq. Inch.	Stubbs' Wire Gauge.	Diameter in Inches.	Price Per Set.
....	401	20	400	28	8	\$8.00
....	402	30	900	31	8	

SPECIAL SCALE

TO ASCERTAIN THE FINENESS OF CEMENT.



This Scale will weigh one pound to ten-thousandths of a pound
avoirdupois.

Price, \$13.00

7,000 grains equal one pound avoirdupois.

One ten-thousandth of a pound equals 7-10 of a grain.

156 $\frac{1}{4}$	"	"	"	"	"	$\frac{1}{4}$	of an ounce.
312 $\frac{1}{2}$	"	"	"	"	"	$\frac{1}{2}$	" "
468 $\frac{3}{4}$	"	"	"	"	"	$\frac{3}{4}$	" "
625	"	"	"	"	"	1	ounce.
2,500	"	"	"	"	"	$\frac{1}{4}$	of a pound.
5,000	"	"	"	"	"	$\frac{1}{2}$	" "
7,500	"	"	"	"	"	$\frac{3}{4}$	" "

JUN 10 1904



THE FAIRBANKS CO.

New York, N. Y., Broome and Elm Streets
Baltimore, Md., 314 North Street
New Orleans, La., 610-612 Canal Street
Buffalo, N. Y., 210-212 Main Street
Syracuse, N. Y., 251-253 West Fayette St.
Albany, N. Y., 364-366 Broadway
Philadelphia, Pa., 701-705 Arch Street
Pittsburgh, Pa., 316-318 Second Avenue
Boston, Mass., 38-44 Pearl Street
Montreal, Canada, 747-749 Craig Street
Toronto, Canada, 124 Bay Street
Winnipeg, Man., Bannatyne and Arthur Sts.
Vancouver, B. C., Hastings Street
London, England, 78-80 City Road, E. C.